Precision Analog Microcontrollers

Features

- Microcontrollers for industrial, instrumentation, medical, communications, and automotive applications
- Leading edge, mixed-signal integration, with 12-, 16-, or 24-bit ADCs, multiple 12-bit D/As, reference and temperature sensor.
- ARM7TDMI (44 MHz) Flash/EE and 1 MSPS 12-bit analog I/O in 6 mm × 6 mm LFCSP
- 3-phase PWM, quadrature encoder PLA and up to 128 kB Flash/EE, plus 8 kB SRAM
- Fully integrated solution for automotive battery monitoring (ADuC703x series)
- 8052 MicroConverter® series with Flash/EE and 12-bit to 24-bit analog I/O
- Complete suite of development tools

Precision Analog Microcontrollers—ARM7® and 8051 Series

Analog Devices precision analog microcontrollers combine precision analog functions, such as high resolution ADCs and DACs, a voltage reference, and temperature sensor with an industry-standard microcontroller and flash memory. For example, the ADuC702x ARM7TDMI family integrates 12-bit analog I/O with flash, SRAM, and a host of digital peripherals. These devices use a single 32-bit bus for instructions and data, integrate a JTAG test port for debug access, and operate up to 44 MHz. In addition to the 32-bit ARM instruction set, the core supports an instruction set that is compressed into 16 bits (Thumb mode). The on-chip precision analog I/O includes a multichannel 1 MSPS, 12-bit A/D converter, up to four 12-bit voltage-output D/A converters, a low drift band gap voltage reference, a temperature sensor, 3-phase PWM, a user-configurable PLA, and an uncommitted voltage comparator. All of this, and more, come in a variety of package footprints with the smallest being a tiny 6 mm × 6 mm, 40-lead chip scale package.

Getting more application specific, the ADuC7128/ADuC7129 extend the ADuC702x series to include a quadrature encoder and PWM for dc motor control applications. They also feature a 32-bit, 22 MHz DDS input followed by a high speed 10-bit DAC, and a 100 Ω line driver, useful for transducer excitation.

The ADuC703x series specifically for automotive battery monitoring, integrates up to three 16-bit ADCs to measure battery voltage, current and temperature, the required high voltage I/O for direct battery interface and a LIN transceiver to handle communications to the engine control unit.

The ADuC8xx series is based on an 8051 core, include flash and SRAM, and variants with 24-bit Σ-Δ A/D front ends. These are particularly suited to direct connection and signal processing in precision sensor applications.

ARM7 Core Products with Precision 12-Bit Analog I/O (ADuC7019 to ADuC7028, ADuC7128, and ADuC7129)

Architectural Overview

The ARM7TDMI core is a 32-bit RISC machine. It uses a single 32-bit bus for instructions and data. The TDMI option provides four additional features: a secondary 16-bit "Thumb (T)" instruction set, debug (D) support, support for long multiples (M), and includes the embedded ICE (I) module containing the breakpoint and watchpoint registers, which allow code to be halted for debugging purposes.

Each ADuC7xxx device operates from an accurate (3%) on-chip oscillator and PLL generating an internal 41.7 MHz clock that is routed through a programmable clock divider from which the MCU operating frequency is generated. Alternatively, the parts can run from a master clock up to 44 MHz. Power consumption is 1 mA/MHz.

Either 126 kB, 62 kB, or 32 kB of nonvolatile Flash/EE and 8 kB of SRAM are provided on-chip with both blocks mapped into a single linear array. ARM code can run directly from SRAM at 41.7 MHz/44 MHz (internal/external clock), given that the SRAM is configured as a 32-bit wide memory array. The 80-lead devices support external memory.

On-chip firmware supports in-circuit serial download via the UART or I²C® and JTAG serial interface ports while nonintrusive emulation is also supported via the JTAG interface.

Key Features

- ARM7TDMI MCU Core
- 16-/32-bit RISC architecture, 44 MHz operation
- Embedded JTAG for debug

Memory Organization

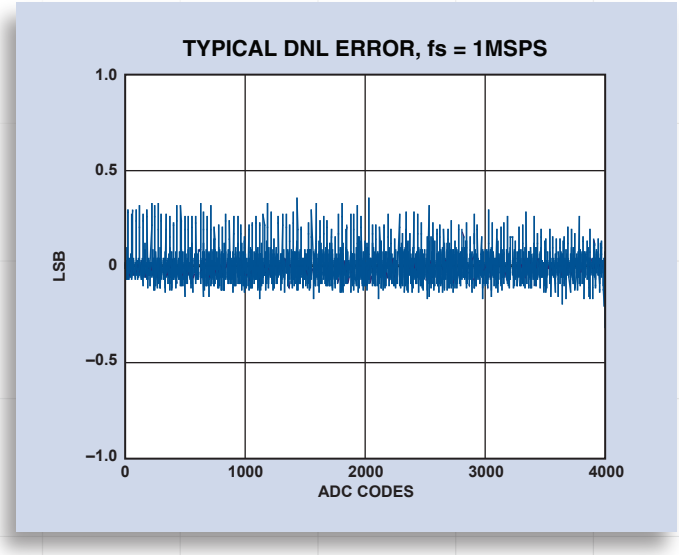
- 8 kB SRAM in 2k × 32 bits
- Up to 126 kB Flash/EE in 31k × 16 bits
- Retention: 20 years
- Endurance: >10k cycles
- In-system programming (ISP) via UART, I²C, or JTAG ports

Analog I/O

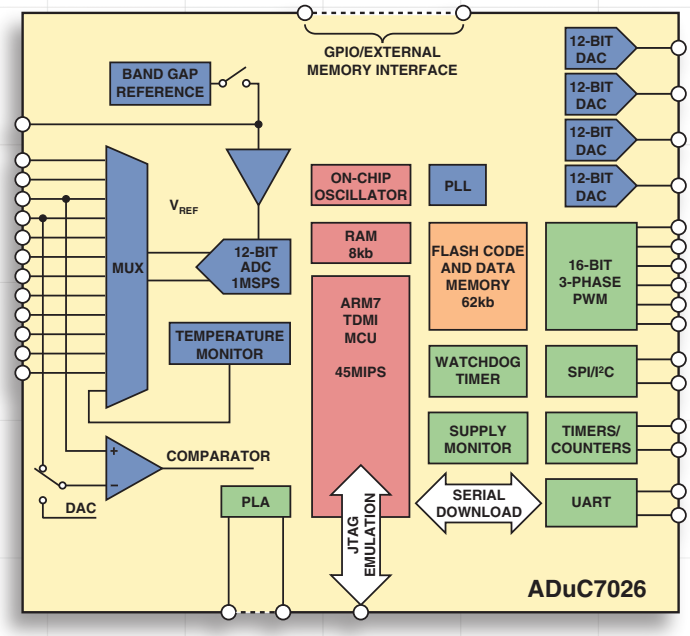
- Multichannel, 12-bit, 1 MHz ADC
- Multiple 12-bit V_{OUT} DACs
- 40 ppm/°C V_{REF}, 3°C temp sensor
- Uncommitted comparator

Others

- 2 × GP timers
- Programmable logic array (PLA)
- UART, SPI,® dual I²C, serial I/O
- Up to 40 GPIO pins
- Power supply monitor and power-on reset
- 3-phase PWM
- Specified for 3 V operation (5 V compatible I/O)
- Temperature range: –40°C to +125°C
- 6 mm × 6 mm and 9 mm × 9 mm LFCSP, 64-lead and 80-lead LQFP package options
- 1 mA/MHz current consumption
- Low cost QuickStart Development System support



Differential nonlinearity plot of 12-bit ADC on ADuC7xxx device with core running at full speed.



ADuC7xxx Series On-Chip Peripherals

High performance analog I/O and several other peripherals are included on-chip. Some of them are examined here. See the selection guide for a complete listing.

12-Bit A/D Converter

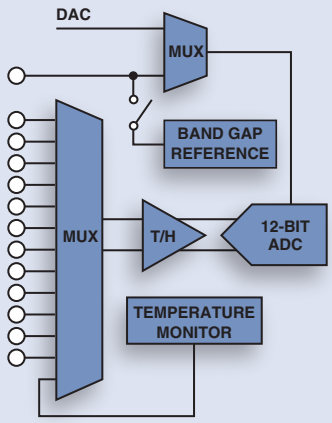
- Key specs @ 1 MSPS
  - INL = ±0.5 LSB
  - Offset/gain = ±0.5 LSB
  - SNR = 71 dB
- Input ranges: 0 to V_{REF} or ±V_{REF}
- Input modes: single, pseudo, and fully differential
- Trigger modes
  - External CONVST pin
  - Timer overflow
  - Software trigger
  - PLA trigger
  - Continuous
  - Up to 16 channels (ADuC7027)

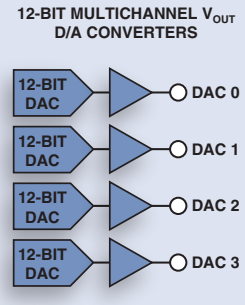
12-Bit Multichannel V_{OUT} D/A Converter

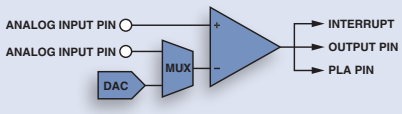
- Monotonic to 12 bits
- Buffered/unbuffered outputs
- 10 µs settling time
- Output range of 0 V to V_{DD}
- 4 DACs on the ADuC7020/ADuC7026/ ADuC7028
- 2 DACs on the ADuC7021/ADuC7024
- 3 DACs on the ADuC7019

Voltage Comparator

The comparator can be configured to generate an interrupt if a voltage input exceeds a threshold level. The threshold voltage can be set via an external pin or by using one of the on-chip 12-bit DACs. The output of the comparator can also be routed both to the on-chip PLA and digital output pin, or to the on-chip interrupt controller. The comparator features 10 mV hysteresis and 1 microsecond response.

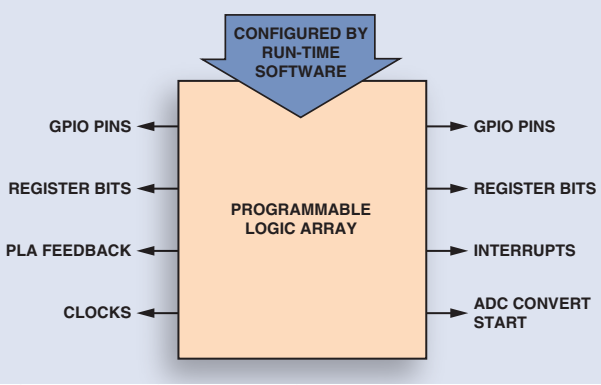


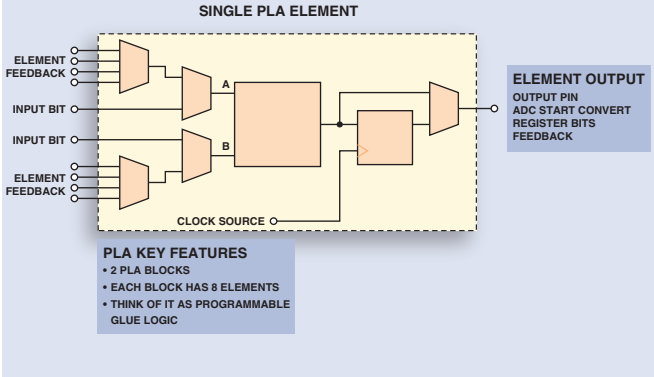




Programmable Logic Array (PLA)

The integrated PLA consists of two interconnected blocks of eight PLA elements for added flexibility. Each element can be configured to generate any logic output function based on two inputs, eliminating the need for external logic gates. The PLA is programmed with run-time code via the standard memory-mapped register (MMR) interface.





ARM7 Series with Quadrature Encoder and H-Bridge PWM for Motor Control

ADuC7128/ADuC7129

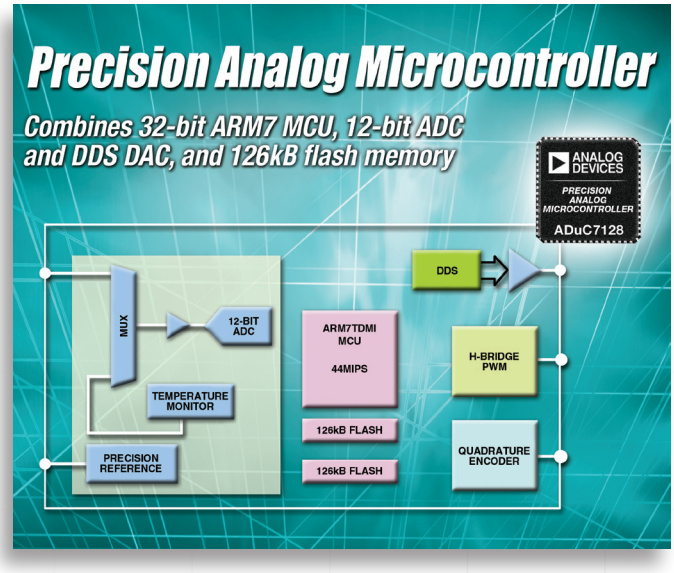
The ADuC7128/ADuC7129 combine an ARM7 microcontroller, 12-bit, 1 MSPS ADC, and a 10-bit DAC, along with a 16-bit PWM with H-bridge mode and quadrature encoder. There is a 32-bit, 22 MHz DDS input to the DAC, which also incorporates a 100 Ω line driver. This level of integration benefits designers of brushless dc (BLDC) and instrumentation systems, reducing external component count, while working in a familiar ARM7 environment.

Key Features

- ARM7 with 126 kB flash
- 10-bit DAC with 32-bit, 22 MHz DDS
- 16-bit PWM generator
- 10-channel, 12-bit, 1 MSPS ADC
- Quadrature encoder
- Temperature range: –40°C to +125°C

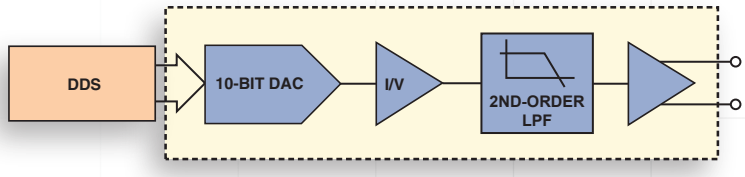
Others

- Dual UART
- Differential line driver output
- 64-lead LFCSP package and 80-lead LQFP package (external memory)



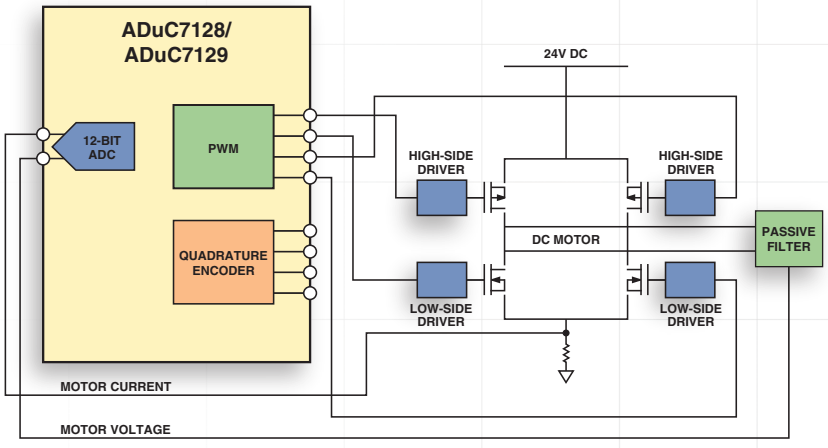
DDS DAC Operation

- 32-bit DDS register
- 4096 point table
- 0.005 Hz resolution
- Minimum frequency: 0.005 Hz
- Maximum frequency limited by LPF
- THD: 51 dB typ



Application Focus: ADuC7128/ADuC7129 in H-Bridge Motor Control

The ADuC7128 integrates a 6-channel PWM interface. The PWM outputs can be configured to drive an H-bridge or can be used as standard PWM outputs. On power-up, the PWM outputs default to H-bridge mode. This ensures that the motor is turned off by default. In standard PWM mode the outputs are arranged as three pairs of PWM pins. Users have control over the period of each pair of outputs and of the duty cycle of each individual output.



Integrated Battery Sensor for Automotive Battery Monitoring Includes High Voltage Physical Interface for LIN

ADuC703x Family

The ADuC703x family of automotive battery monitor solutions address a growing need to monitor and distribute power and provide priority to critical functions such as engine startup. The ADuC703x family measures elementary physical variables such as battery voltage, current, and temperature to determine the battery's state-of-charge (SOC) and state-of-health (SOH). The vehicle's energy management system then uses this data to reserve sufficient battery energy for a guaranteed engine start and to tailor the charging cycles resulting in reduced fuel consumption.

The ADuC703x family integrates an on-chip PGA (programmable gain amplifier) for a wide range of battery current measurements and, similarly, attenuation for battery voltage measurement. Also on board are up to three 16-bit analog-to-digital converters (ADCs), an ARM7 microcontroller, a local interconnect network (LIN) transceiver, and embedded memory in a single package. The devices offer a cost-efficient and space-saving alternative to discrete solutions, which consists of a standalone processor, LIN transceiver, low dropout regulator (LDO), and analog front end (AFE). As a result, the component can be located between the battery terminal and the connector on the main power cable, giving a great saving in space and cost, while simplifying overall battery monitoring system design.

Key Features

- ARM7TDMI MCU core
- Operates from 12 V battery supply
- Low power consumption
- 175 μA in low power mode
- Up to 10 mA at 10 MHz in regular mode

Memory Organization

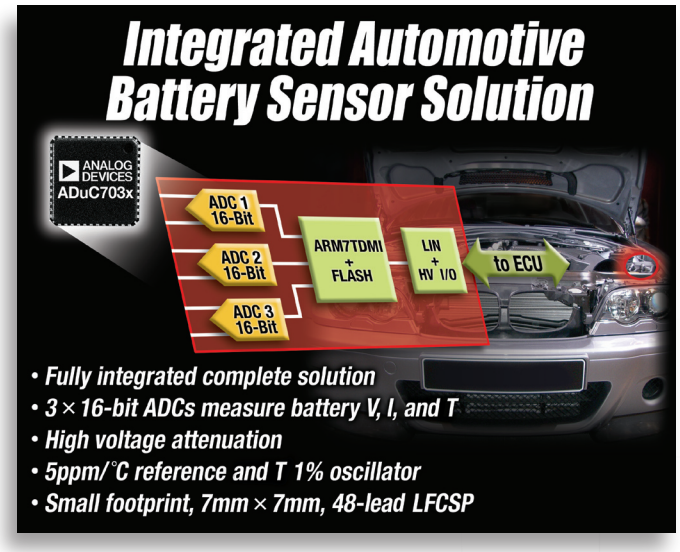
- 6 kB SRAM
- 96 kB Flash/EE
- Retention: 20 years @ 85°C

Analog I/O

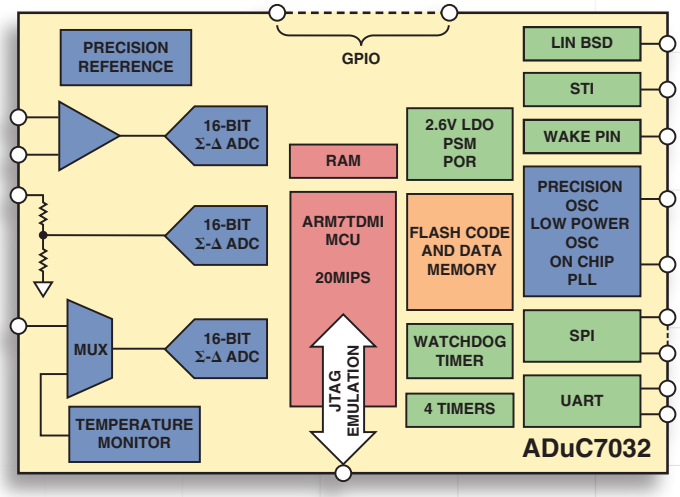
- 3 × 16-bit, Σ-Δ ADC
- 5 ppm/°C V_{REF}
- 2°C temperature sensor
- Digital comparator and integrator

Others

- Programmable gain amplifier (PGA)
- PLL
- Precision oscillator (1%)
- Timers (watchdog, wake-up, 2 × GP)
- Power supply monitor
- Power-on reset
- LIN (local interconnect network) transceiver
- Temperature range: –40°C to +125°C
- 7 mm × 7 mm, 48-lead LFCSP package


Integrated Automotive Battery Sensor Solution
ANALOG DEVICES
ADuC703x
ADC 1 16-Bit
ADC 2 16-Bit
ADC 3 16-Bit
ARM7TDMI + FLASH
LIN + HV I/O
to ECU
• Fully integrated complete solution
• 3 × 16-bit ADCs measure battery V, I, and T
• High voltage attenuation
• 5ppm/°C reference and T 1% oscillator
• Small footprint, 7mm × 7mm, 48-lead LFCSP

For automotive battery performance management, the integration of leading-edge data converters and high voltage circuits with a high end, industry-standard MCU and flash memory has provided the automotive designer with a high performance, low cost, easy to use solution.



Product	ADCs	Flash (kB)	SRAM (kB)	Timers	Package	Price @ 1k ($U.S.)
ADuC7030	2	32	4	5	48-lead LFCSP, 48-lead LQFP	6.73
ADuC7032	3	96	6	4	48-lead LQFP	7.55
ADuC7033	2	96	6	5	48-lead LFCSP, 48-lead LQFP	7.10

Precision Analog Microcontroller (MicroConverter) Products

Part Number	MCU, MIPS (Peak)	Flash Code (Bytes)	Flash Data (Bytes)	RAM (Bytes)	External Memory Interface	Power Supply (V)	GPIOs[1]	Download/ Debug	ADCs	DACs	Temp Sensor Accuracy (°C)[2]
Fast Successive Approximation 12-Bit A/D Precision Analog Microcontroller Products with ARM7 Core											
ADuC7019	ARM7, 44	62k		8k	None	2.7 to 3.6	14	JTAG + UART/I²C[6]	12-bit, 5-channel (2 differential), 1 MSPS	12-bit, triple	±3.0
ADuC7020	ARM7, 44	62k		8k	None	2.7 to 3.6	14	JTAG + UART/I²C[6]	12-bit, 5-channel (2 differential), 1 MSPS	12-bit, quad	±3.0
ADuC7021	ARM7, 44	62k, 32k		8k	None	2.7 to 3.6	13	JTAG + UART/I²C[6]	12-bit, 8-channel (4 differential), 1 MSPS	12-bit, dual	±3.0
ADuC7022	ARM7, 44	62k, 32k		8k	None	2.7 to 3.6	13	JTAG + UART/I²C[6]	12-bit, 10-channel (5 differential), 1 MSPS	None	±3.0
ADuC7024	ARM7, 44	62k		8k	None	2.7 to 3.6	30	JTAG + UART/I²C[6]	12-bit, 10-channel (5 differential), 1 MSPS	12-bit, dual	±3.0
ADuC7025	ARM7, 44	62k, 32k		8k	None	2.7 to 3.6	30	JTAG + UART/I²C[6]	12-bit, 12-channel (5 differential), 1 MSPS	None	±3.0
ADuC7026	ARM7, 44	62k		8k	Code and data	2.7 to 3.6	40	JTAG + UART/I²C[6]	12-bit, 12-channel (6 differential), 1 MSPS	12-bit, quad	±3.0
ADuC7027	ARM7, 44	62k		8k	Code and data	2.7 to 3.6	40	JTAG + UART/I²C[6]	12-bit, 16-channel (8 differential), 1 MSPS	None	±3.0
ADuC7028	ARM7, 44	62k		8k	None	2.7 to 3.6	30	JTAG + UART/I²C[6]	12-bit, 8-channel (4 differential), 1 MSPS	12-bit, quad	±3.0
New SAR 12-bit A/D Microconverter Products with ARM7 Core for Industrial Applications											
ADuC7128	ARM7, 44	126k		8k	None	3.0 to 3.6	28	JTAG + UART/I²C[6]	12-bit, 10-channel (5 differential), 1 MSPS	10-bit DAC, PWM	±3.0
ADuC7129	ARM7, 44	126k		8k	Code and Data	3.0 to 3.6	38	JTAG + UART/I²C[6]	12-bit, 10-channel (5 differential), 1 MSPS	10-bit DAC PWM	±3.0
New Σ-Δ (16-bit A/D) Microconverter Products with ARM7 Core for Automotive Battery Management											
ADuC7030	ARM7, 20	32k		4k	None	3 to 18	9	JTAG	2 × 16-bit Σ-Δ ADC	——	±2.0
ADuC7032	ARM7, 20	96k		6k	None	3 to 18	9	JTAG	3 × 16-bit Σ-Δ ADC	——	±2.0
ADuC7033	ARM7, 20	96k		6k	None	3 to 18	9	JTAG	2 × 16-bit Σ-Δ ADC	——	±2.0
Multichannel Σ-Δ (24-Bit and 16-Bit A/D) MicroConverter Products with 8052 Core											
ADuC845	8052, 12	62k, 32k, 8k	4k	2k + 256	Data only	2.7 to 3.6 4.75 to 5.25	32	Single pin or UART	24-bit, dual, 1.3 kSPS	12-bit, single	±1.5
ADuC847	8052, 12	62k, 32k, 8k	4k	2k + 256	Data only	2.7 to 3.6 4.75 to 5.25	32	Single pin or UART	24-bit, 1.3 kSPS	12-bit, single	None
ADuC848	8052, 12	62k, 32k, 8k	4k	2k + 256	Data only	2.7 to 3.6 4.75 to 5.25	32	Single pin or UART	16-bit, 1.3 kSPS	12-bit, single	None
Σ-Δ (24-Bit and 16-Bit A/D) MicroConverter Products with 8052 Core											
ADuC816	8052, 1.0	8k	640	256	Code and data	2.7 to 5.25	32	Single pin or UART	16-bit, dual, 105 kSPS	12-bit, single	±1.5
ADuC824	8052, 1.0	8k	640	256	Code and data	2.7 to 5.25	32	Single pin or UART	24-bit and 16-bit, 105 kSPS	12-bit, single	±1.5
ADuC834	8052, 1.0	62k	4k	2k + 256	Code and data	2.7 to 5.25	32	Single pin or UART	24-bit and 16-bit, 105 kSPS	12-bit, single	±1.5
ADuC836	8052, 1.0	62k	4k	2k + 256	Code and data	2.7 to 5.25	32	Single pin or UART	16-bit, dual, 105 kSPS	12-bit, single	±1.5
Successive Approximation 12-Bit A/D MicroConverter Products with 8052 Core											
ADuC812	8052, 1.3	8k	640	256	Code and data	2.7 to 5.5	32	Single pin or UART	12-bit, 8-channel, 200 kSPS	12-bit, dual	±3.0
ADuC814	8052, 1.3	8k	640	256	None	2.7 to 5.5	16	Single pin or UART	12-bit, 8-channel, 247 kSPS	12-bit, dual	±1.5
ADuC831	8052, 1.3	62k	4k	2k + 256	Code and data	2.7 to 5.5	32	Single pin or UART	12-bit, 8-channel, 200 kSPS	12-bit, dual	±1.5
ADuC832	8052, 1.3	62k	4k	2k + 256	Code and data	2.7 to 5.5	32	Single pin or UART	12-bit, 8-channel, 200 kSPS	12-bit, dual	±1.5
ADuC841	8052, 20	62k, 8k	4k	2k + 256	Data only	2.7 to 3.6 4.75 to 5.25	32	Single pin or UART	12-bit, 8-channel, 400 kSPS	12-bit, dual	±1.5
ADuC842	8052, 16	62k, 32k, 8k	4k	2k + 256	Data only	2.7 to 3.6 4.75 to 5.25	32	Single pin or UART	12-bit, 8-channel, 400 kSPS	12-bit, dual	±1.5
ADuC843	8052, 16	62k, 32k, 8k	4k	2k + 256	Data only	2.7 to 3.6 4.75 to 5.25	32	Single pin or UART	12-bit, 8-channel, 400 kSPS	None	±1.5

[1] Pins that are also analog inputs are limited to digital input only, i.e., GPI, not GPIO. In the case of the ARM7 parts, all pins are full GPIO.

[2] Temperature sensor is calibrated on all Σ-Δ parts, while it is not calibrated on the successive approximation parts.

[3] TIC: time interval counter.

[4] PSM: power supply monitor; WDT: watchdog timer; POR: power-on reset; sources: current sources; burnout: sensor burnout capability; PLA: programmable logic array.

[5] 125°C applies to the MQFP package only.

[6] UART/I²C download only.

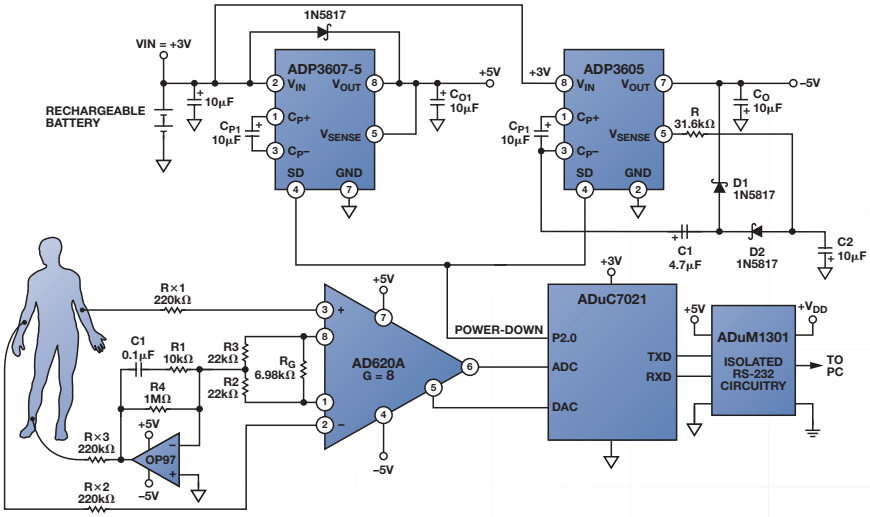
[7] Can be used through PLA.

PWMs	Reference	Serial Ports	Clocking	Timers[3]	Other Peripherals[4]	Temperature Range[5] (°C)	Packages	Price @ 1k ($U.S.)
See note 7	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	6 mm × 6 mm, 40-lead LFCSP	6.34
See note 7	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	6 mm × 6 mm, 40-lead CSP	6.80
See note 7	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	6 mm × 6 mm, 40-lead CSP	4.32
See note 7	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	6 mm × 6 mm, 40-lead CSP	3.98
3-phase, 16-bit	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	9 mm × 9 mm, 64-lead LFCSP, and 64-lead LQFP	7.00
3-phase, 16-bit	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	9 mm × 9 mm, 64-lead LFCSP, and 64-lead LQFP	5.24
3-phase, 16-bit	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	80-lead LQFP	8.80
3-phase, 16-bit	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	80-lead LQFP	6.42
3-phase, 16-bit	Internal 40 ppm or external	UART, SPI, 2 I²C ports	External, internal (3%), PLL (prog)	2 × 32-bit, 2 × 16-bit	PLA, comparator, PSM, POR	–40 to +125	6 mm × 6 mm, 64-ball BGA	6.80
6-channel, 16-bit	Internal 40 ppm or external	2 UART, SPI, 2 I²C ports	External, internal (2%), PLL (prog)	1 × 16-bit, 3 × 32-bit, 1 × 48-bit	PLA, comparator, PSM, POR	–40 to +125	9 mm × 9 mm, 64-lead LFCSP	6.95
6-channel, 16-bit	Internal 40 ppm or external	2 UART, SPI, 2 I²C ports	External, internal (2%), PLL (prog)	1 × 16-bit, 3 × 32-bit, 1 × 48-bit	PLA, comparator, PSM, POR	–40 to +125	9 mm × 9 mm, 64-lead LFCSP	7.74
——	Internal 5 ppm	LIN transceiver, SPI	Internal (1%), PLL (prog)	1 × 16-bit, 3 × 32-bit, 1 × 48-bit	Comparator, wake-up, watchdog	–40 to +125	7 mm × 7 mm, 48-lead LFCSP, 48-lead LQFP	6.73
——	Internal 5 ppm	LIN transceiver, SPI	Internal (1%), PLL (prog)	1 × 16-bit, 3 × 32-bit, 1 × 48-bit	Comparator, wake-up, watchdog	–40 to +125	48-lead LQFP	7.55
——	Internal 5 ppm	LIN transceiver, SPI	Internal (1%), PLL (prog)	1 × 16-bit, 3 × 32-bit, 1 × 48-bit	Comparator, wake-up, watchdog	–40 to +125	7 mm × 7 mm, 48-lead LFCSP, 48-lead LQFP	7.10
Dual, 16-bit	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT, Isources, burnout	–40 to +125	56-lead LFCSP, 52-lead MQFP	8.95
Dual, 16-bit	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT, Isources, burnout	–40 to +125	56-lead LFCSP, 52-lead MQFP	5.85
Dual, 16-bit	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT, Isources, burnout	–40 to +125	56-lead LFCSP, 52-lead MQFP	4.98
None	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × TIC	PSM, WDT, Isources, burnout	–40 to +85	56-lead LFCSP, 52-lead MQFP	9.11
None	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × TIC	PSM, WDT, Isources, burnout	–40 to +85	56-lead LFCSP, 52-lead MQFP	11.29
Dual, 16-bit	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT, Isources, burnout	–40 to +125	56-lead LFCSP, 52-lead MQFP	12.32
Dual, 16-bit	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT, Isources, burnout	–40 to +125	56-lead LFCSP, 52-lead MQFP	9.85
None	Internal or external	UART, SPI, I²C	External	3 × 16-bit	PSM, WDT	–40 to +125	56-lead LFCSP, 52-lead MQFP	8.30
None	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × TIC	POR, PSM, WDT	–40 to +125	28-lead TSSOP	4.52
Dual, 16-bit	Internal or external	UART, SPI, I²C	External	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT	–40 to +125	56-lead LFCSP, 52-lead MQFP	8.76
Dual, 16-bit	Internal or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT	–40 to +125	56-lead LFCSP, 52-lead MQFP	8.76
Dual, 16-bit	Internal 20 ppm or external	UART, SPI, I²C	External	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT	–40 to +85	56-lead LFCSP, 52-lead MQFP	6.56
Dual, 16-bit	Internal 20 ppm or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT	–40 to +85	56-lead LFCSP, 52-lead MQFP	6.56
Dual, 16-bit	Internal 20 ppm or external	UART, SPI, I²C	Internal, PLL	3 × 16-bit, 1 × baud rate, 1 × TIC	POR, PSM, WDT	–40 to +85	56-lead LFCSP, 52-lead MQFP	5.15

Application Focus: Electrocardiogram Using ADuC7021

An electrocardiogram (ECG) is the recording of the electrical activity on the body surface generated by the heart. This electrical activity is collected by skin electrodes placed on predetermined parts of the body. A low cost implementation of an ECG monitor is shown in the schematic here, and for the main signal processing the ADuC7021 microconverter is chosen. This part features the necessary high performance analog peripherals, a fast ARM7 core, integrated 62 kB flash for code, and several other useful peripherals. The ADC converts the analog signal from the differential amplifier to a digital signal. The software, resident in the ADuC7021 flash, then processes the digitized signal to produce the final ECG trace. Because of the flash-based code memory on the ADuC7021, this customization can be done after manufacture or even as the patients needs change.

For more information, see complete technical article at: *www.analog.com/library/analogdialogue/archives/37-11/ecg.pdf.*



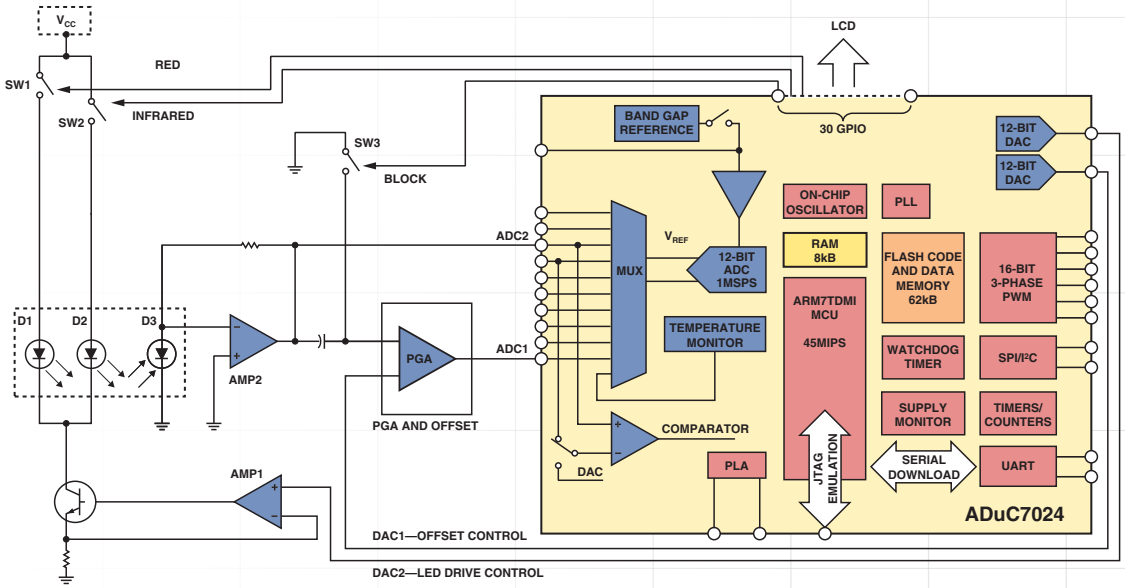
Application Focus: Pulse Oximeter Uses ADuC7024

In addition to heart rate, blood pressure, respiratory rate, and temperature, pulse oximetry is considered to be the "fifth vital sign" of health status. A pulse oximeter is a medical device that provides a noninvasive measure of the amount of oxygen in a patient's arterial blood.

A typical oximetry sensor has a pair of light-emitting diodes (one red with 660 nm wavelength, one infrared with 940 nm wavelength) facing a photodiode through a translucent part of the patient's body, usually a fingertip or an earlobe. The percentage of blood oxygen is calculated based on the absorption rate from each wavelength of light after it passes through the patient's body.

The precision analog microcontroller family of products from Analog Devices includes the key analog building blocks required by a high end oximetry design. The ADuC7024, used here, includes a high performance, high speed, multichannel, 12-bit, 1 MSPS ADC and two DACs. The MicroConverter® device also includes a 32-bit ARM7TDMI core. Running at 41.8 MHz, it provides a very powerful computational platform for digital signal processing algorithm to detect arterial blood pulsations, while allowing plenty of CPU performance for additional functions, such as control of the graphics LCD display. The ADuC7024 MicroConverter device features 30 general-purpose I/Os (GPIOs), required for interfacing with the LCD. With fewer I/Os, the same level of performance could be achieved by using the ADuC7021, available in a space saving 6 mm × 6 mm LFCSP package.

For more information, see complete technical article at: *www.analog.com/library/analogdialogue/archives/41-01/pulse_oximeter.html.*



Energy Measurement IC Integrates ADE Core with 8052 Core

Electricity meter designers face a changing marketplace that is moving from either electromechanical meters or electronic stepper-motor display meters to full electronic LCD display solutions. Designers of these systems need a better solution for this growing demand for feature rich, highly reliable, cost-effective, LCD energy meters. The ADE71xx and ADE75xx energy meter SoC (system-on-a-chip) families provide a cost-effective solution for meter manufacturers by integrating ADI's proven energy measurement core with the 8052 microprocessor, on-chip flash memory, LCD driver, real-time clock (RTC), and intelligent battery management. The ADE71xx and ADE75xx families have unique battery management features that consume less than 1.5 μA of current in battery mode while keeping critical system components active. In addition, the SoCs have optimal power supply management when line voltage is being lost. Based on ADI's field-proven ADE energy measurement core that is designed into more than 175 million energy meters worldwide, these highly integrated SoC devices provide a high performance, cost-effective, and low risk solution.

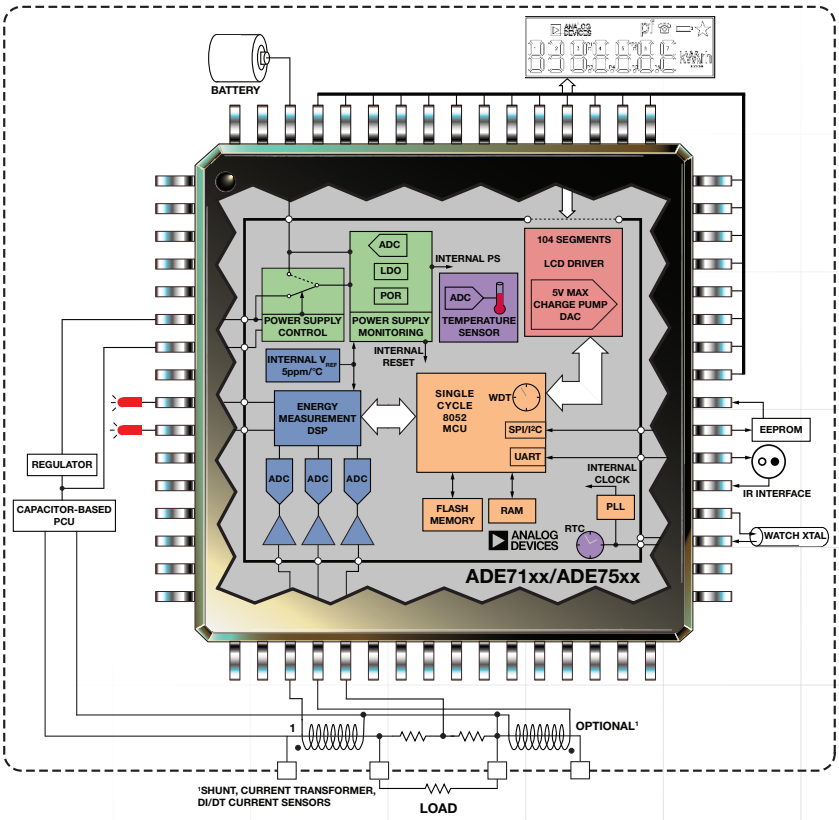
For more information, visit *www.analog.com/energymeter.*

Key Features

- 4-quadrant high precision energy measurement
- Battery operation down to 2.4 V power supply
- Power fail/battery management with no external component needed
- 104-segment LCD driver
- Adjustable LCD drive voltage up to 5 V independent of power supply
- Low power RTC—1.5 μA typical
- RTC compensation accurate to 2 ppm
- V_{REF} 5 ppm/°C typical
- Digital temperature measurement
- Noninvasive in-circuit emulation
- On-chip flash memory with read/write/erase protections

Key Benefits

- Single chip solution
- No external battery switching circuitry required
- LCD display maintained in battery mode
- Extended battery life with low voltage operation
- Integrated LCD contrast adjustment
- Communication maintained in battery mode
- Digital temperature compensation of RTC and LCD contrast



Part Number	Antitamper	W + VA + rms	VAR	di/dt	5 V LCD	RTC	Flash (kB)	Package
ADE7566F8	No	Yes	No	No	Yes	Yes	8	64-lead LQFP
ADE7566F16	No	Yes	No	No	Yes	Yes	16	64-lead LQFP
ADE7569F16	No	Yes	Yes	Yes	Yes	Yes	16	64-lead LQFP
ADE7166F8	Yes	Yes	No	No	Yes	Yes	8	64-lead LQFP
ADE7166F16	Yes	Yes	No	No	Yes	Yes	16	64-lead LQFP
ADE7169F16	Yes	Yes	Yes	Yes	Yes	Yes	16	64-lead LQFP

QuickStart Development Tools ADuC7xxx Series

All ADuC7xxx series precision analog microcontroller products are supported by a comprehensive suite of software development tools that are shipped with supporting hardware. The ADuC7xxx series low cost QuickStart Development System includes a suite of software development tools by Kiel Software and IAR Systems. The hardware includes a power supply, cables, an evaluation board, and an RDI-compliant JTAG emulator. The QuickStart Development System is priced at $249 (with emulator) and at $75 (without emulator) and is available directly from Analog Devices.

All you need to get started …

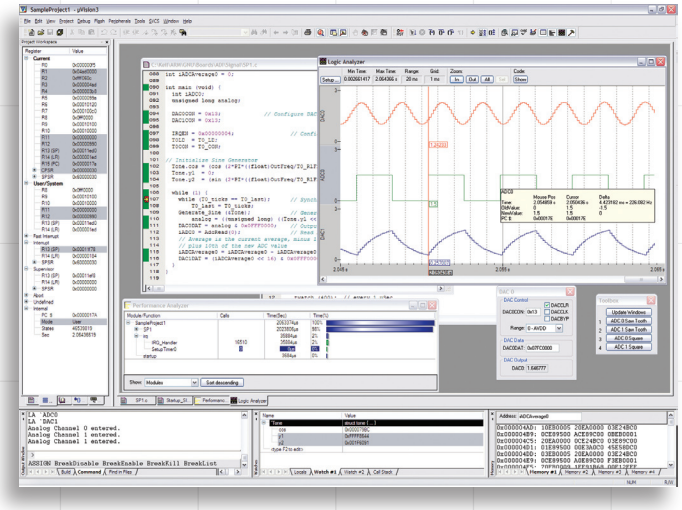
- Evaluation board
- ADI mIDAS-Link JTAG emulator
- Power supply
- Serial download cable
- Keil µVision3 IDE (16k limit)
- IAR Systems WorkBench for ARM (32k limit)
- Serial downloader
- PLA Tool

Components of the ADuC7xxx Series QuickStart Development System.

Development Systems	Part on Eval Product	Board Type/ Description	Products Supported	Emulator	Cables/Power Supply	Description
Mini Kit ($30)	ADuC7020	Mini board	ADuC7020 only	No	Serial cable	Prototyping system
QuickStart Kit ($75)	ADuC7020	Evaluation board	ADuC7019, ADuC7020, ADuC7021, ADuC7022	No	Serial cable and power supply	Evaluation/upgrade system
QuickStart Kit ($75)	ADuC7024	Evaluation board	ADuC7024, ADuC7025	No	Serial cable and power supply	Evaluation/upgrade system
QuickStart Kit ($75)	ADuC7026	Evaluation board	ADuC7026, ADuC7027	No	Serial cable and power supply	Evaluation/upgrade system
QuickStart Plus Kit ($249)	ADuC7128	Evaluation board	ADuC7128	Yes	Serial cable and power supply	Full development system
QuickStart Plus Kit ($249)	ADuC7129	Evaluation board	ADuC7129	Yes	Serial cable and power supply	Full development system
QuickStart Plus Kit ($249)	ADuC7033	Evaluation board	ADuC7030, ADuC7033	Yes	Serial cable and power supply	Full development system
QuickStart Plus Kit ($249)	ADuC7032	Evaluation board	ADuC7032	Yes	Serial cable and power supply	Full development system
QuickStart Plus Kit ($249)	ADuC7026	Evaluation board	ADuC7019, ADuC702x	Yes	Serial cable and power supply	Full development system

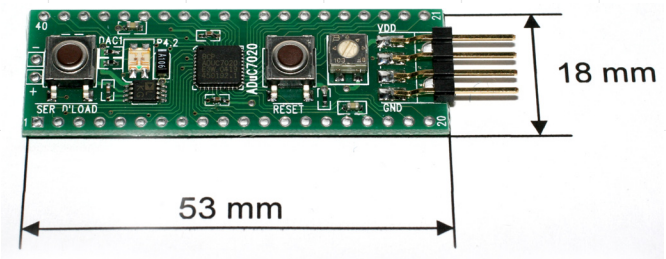
Minikit—ADuC7020

For a rapid start with the ARM7TDMI-based precision analog microcontroller, Analog Devices is offering a very low cost evaluation kit, the ADuC7020 Mini Kit. This is a small adapter board with the form factor of a standard 40-pin DIL-socket. It is powered directly from a 9 V battery block and can be connected to a PC with the included serial download cable. In addition to the evaluation software package, it comes with a comprehensive installation and getting-started presentation on CD, to enable the user to debug code in the on-chip flash memory. This low budget evaluation tool enables the user to experience the quality of the high performance 12-bit analog front end (12-bit/1MSPS ADC and 12-bit voltage output DAC) in combination with the powerful processing capabilities of the 32-/16-bit ARM7TDMI core and the integrated real-time-programmable logic array (PLA).



The mini kit consists of:

- Mini board
- Power supply cable
- Serial download cable
- Keil µVision3 IDE (16k limited)
  - compiler/simulator/debugger
- IAR Workbench IDE (32k limited)
  - compiler/simulator/debugger
- Serial downloader
- PLA tool
- Example code



ADuC8xx Series: 8052-Based Microconverters Products

The ADuC8xx series were the first to integrate true 12-bit to 24-bit analog precision, in-circuit reprogrammable flash/EE memory, and an on-chip 8052 core. Applications include industrial control, precision instrumentation, and communications infrastructure. Options with high resolution Σ-Δ A/Ds, such as ADuC845, ADuC847, and ADuC848, are particularly suitable for applications that call for precise measurement of low frequency signals with a wide dynamic range. Examples include intelligent sensor calibration and conditioning, smart transmitters, weigh scales, temperature and pressure transducers, 4 to 20 mA control loops, patient monitoring equipment, and portable test-and-measurement gear.

Precision Analog

- 12-bit to 24-bit ADC resolution
- Sample rates to 400 kSPS
- Flexible ADC input multiplexing
- Programmable gain differential inputs
- Self-calibration
- On-chip 2.5 V band gap reference
- Single or dual, 12-bit rail-to-rail DAC

Integrated Programmable Peripherals

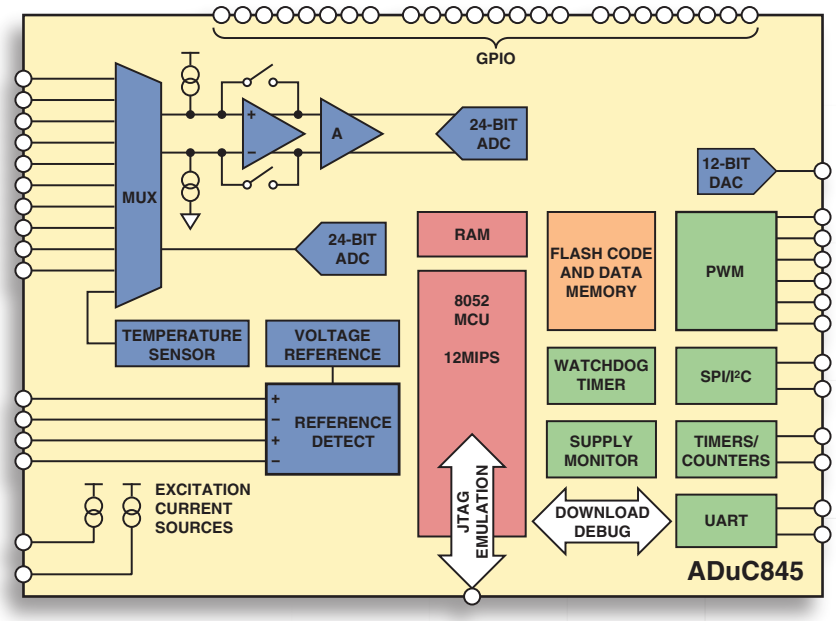
- 8052 MCU core (up to 20 MIPS)
- Flash code memory (up to 62k)
- Flash data memory (up to 4k)
- RAM (up to 2k)
- Flexible SPI, I²C, and UART serial ports
- High speed baud rate generator
- Multiple PWM outputs
- Watchdog timer
- Power supply monitor
- Robust internal POR

Essential Embedded Tools

- Serial port downloader/debugger
- Single pin emulator
- Code lockout security feature

Other Features

- TSSOP, MQFP, and CSP packages
- Extended temperature range to 125°C
- Pin-compatible upgrade paths
- 3 V and 5 V operation



The ADuC845 features two 24-bit Σ-Δ analog-to-digital converters (ADCs) with 10 single-ended or five fully differential channels on a single chip. This is integrated with a fast, programmable, 8-bit, single-cycle, 8052 flash MCU.

QuickStart Development Tools ADuC8xx Series

The "entry level" Quickstart Development System allows designers to rapidly evaluate MicroConverter performance and functionality, and then begin a prototype development. The system provides all of the tools needed, including software tools, development board, integrated serial download/debug cable, and power supply. It fully supports assembly level code development via a serial port debug path and provides designers with access to a demonstration project of the C-level development environment available in QuickStart Plus.

Components of the ADuC8xx Series QuickStart Plus Development Tools

The enhanced QuickStart Plus Development System is a powerful, comprehensive environment incorporating a small, nonintrusive, single-pin, emulator POD, development/prototyping board, and the new aspire Integrated Development Environment (IDE). This third-party development system is supplied directly by Accutron Ltd. and can be ordered via the company's website.

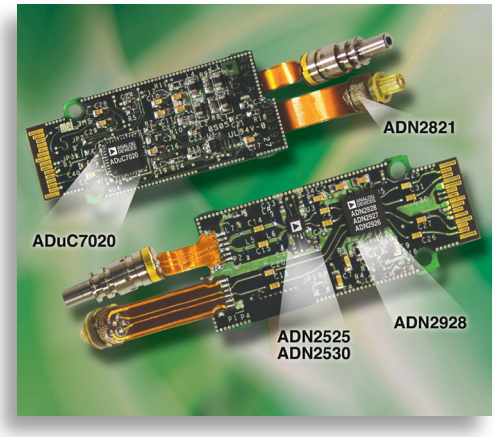
Development Systems	Support Product	Board	Emulator	Cables/Power Supply	Software
QuickStart Kit ($75)	ADuC8xx series	Evaluation board	No	Download/debug cable and power supply	IDE (assembly only)
QuickStart Plus Kit ($299)	ADuC8xx series	Evaluation board	Yes	Serial cable and power supply	IDC (C + assembly), Keil compiler (trial version)

Transceiver Module with SFP and XFP Chipset and Reference Design

Analog Devices' chipsets and reference designs work seamlessly together and enable designers to develop best-in-class optical transceivers with minimal time and effort. XFP is rapidly becoming the leading standard for optical transceiver modules that connect to 10 Gbps ports, such as those used in Ethernet, Fibre Channel, and SONET/SDH protocol applications.

The chipset consists of:

- TIA:
  - ADN2821, 11.1 Gbps, 3.3 V, low noise, high gain transimpedance amplifier
- LDD:
  - ADN2525, 10 Gbps active back-match, differential laser diode driver
  - ADN2530, 10 Gbps active back-termination VCSE driver
- XFP Signal Conditioner:
  - ADN2926/ADN2927, standalone transmit and receive functions in a 4 mm × 4 mm LFCSP
  - ADN2928, XFP single chip transceiver IC
- Microcontroller:
  - ADuC7020, precision analog microcontroller: 44 MIPS ARM7 flash MCU, 5-channel, 1 MSPS, 12-bit ADC, quad 12-bit DAC, two I²C ports, in 6 mm × 6 mm, 40-lead LFCSP



For more information, visit: *www.analog.com/xfp_ref_design* and *www.analog.com/sfp_ref_design.*

Where to Go for Information

Reference Materials	
Analog Microcontroller Home Page	*www.analog.com/microconverter*
Selection Guides	*www.analog.com/MCUselection*
Net Seminars	*www.analog.com/OnlineSeminar*
Signal Chains	*www.analog.com/signalchains*
Related Websites	
ARM7	*www.arm.com*
8052	*www.8052.com/tutorial*
Samples	*www.analog.com/BuyOnline*

For more information on Analog Devices' range of precision analog microcontrollers, visit *www.analog.com/microcontroller.*

Analog Devices, Inc.
Worldwide Headquarters
Analog Devices, Inc.
One Technology Way
P.O. Box 9106
Norwood, MA 02062-9106
U.S.A.
Tel: 781.329.4700
(800.262.5643,
U.S.A. only)
Fax: 781.461.3113

Analog Devices, Inc.
Europe Headquarters
Analog Devices, Inc.
Wilhelm-Wagenfeld-Str. 6
80807 Munich
Germany
Tel: 49.89.76903.0
Fax: 49.89.76903.157

Analog Devices, Inc.
Japan Headquarters
Analog Devices, KK
New Pier Takeshiba
South Tower Building
1-16-1 Kaigan, Minato-ku,
Tokyo, 105-6891
Japan
Tel: 813.5402.8200
Fax: 813.5402.1064

Analog Devices, Inc.
Southeast Asia
Headquarters
Analog Devices
22/F One Corporate Avenue
222 Hu Bin Road
Shanghai, 200021
China
Tel: 86.21.5150.3000
Fax: 86.21.5150.3222

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